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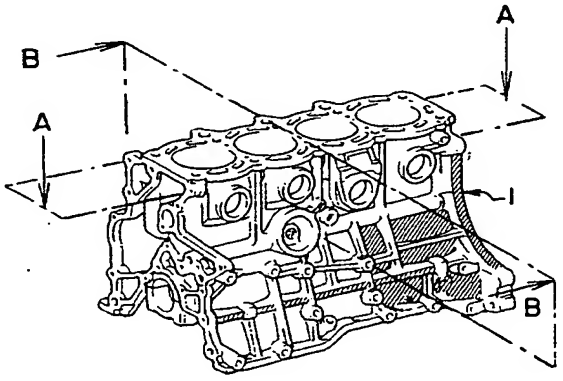
(54) Cylinder block for an internal combustion engine.

(57) A cylinder block for an internal combustion engine includes a bolt boss (6) located between cylinders, the bolt boss (6) being connected to a common wall portion (5) of a siamese bore wall structure by a double bridge structures including a lower bridge (11, 11', 11") and an upper bridge (12) located above the lower bridge. Since a composite moment E_0 acting on the bolt boss (6) during the tightening of a head bolt is directed in a plane including the common wall portion (5), the composite moment can be born by the common portion (5) which has a very large rigidity in a direction perpendicular to the row of cylinder bores. As a result, deformation of the bolt boss (6) is suppressed, and deformation of the cylinder bore and inclination of the top deck are also effectively suppressed.

FIG. 1



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by means of the double bridge structure, the bending rigidity of the bolt boss located between cylinders is increased. As a result, the fourth-mode deformation of the intermediate cylinder bores can be decreased, and deformation of the upper deck is also decreased.

The above-described object and other objects, features, and advantages of the present invention will become more apparent and will be more readily appreciated from the following detailed description of the preferred embodiments of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an oblique view of a cylinder block for an internal combustion engine in accordance with a first embodiment of the present invention;

FIG. 2 is a cross-sectional view of the cylinder block of FIG. 1 taken along line A - A;

FIG. 3 is a cross-sectional view of the cylinder block of FIG. 1 taken along line B - B;

FIG. 4 is a partial plan view of the cylinder block of FIG. 1;

FIG. 5 is a cross-sectional view of a double bridge structure of the cylinder block of FIG. 4 taken along line C - C, illustrating a dimensional relationship between an upper bridge and a lower bridge;

FIG. 6 is a cross-sectional view of a cylinder block for an internal combustion engine in accordance with a second embodiment of the present invention;

FIG. 7 is a cross-sectional view of a cylinder block for an internal combustion engine in accordance with a third embodiment of the present invention;

FIG. 8 is a partial plan view of the cylinder block of FIG. 7;

FIG. 9 is a cross-sectional view of the lower bridge of the cylinder block of FIG. 7;

FIG. 10 is a partial cross-sectional view of a conventional cylinder block illustrating deformations of a cylinder bore wall and a top deck when a head bolt is tightened;

FIG. 11 is a vector diagram of bending moments generated in the cylinder block of FIG. 10 when a head bolt is tightened;

FIG. 12 is a plan view of the cylinder block of FIG. 10 illustrating a deformation of the cylinder bore;

FIG. 13 is a schematic, cross-sectional view of a cylinder block disclosed in Japanese Utility Model Publication SHO 59-24846; and

FIG. 14 is a cross-sectional view of the cylinder block of FIG. 13 illustrating a deformation of the cylinder block when a head bolt is tightened.

FIGS. 1 - 5 illustrate a first embodiment of the invention.

In FIGS. 1 - 5, a cylinder block 1 for an internal combustion engine is, for example, a cylinder block of a four-cylinder engine. The cylinder block 1 includes a monolithic, siamese bore wall structure 2 and a cylinder block outside wall 3 surrounding the bore wall structure 2 with a space for a water jacket between the bore wall structure 2 and the cylinder block outside wall 3. The bore wall structure 2 defines a plurality of cylinder bores which are arranged in a row and in parallel with each other. The bore wall structure 2 includes a plurality of independent bore wall portions 4 and a common wall portion 5 located between adjacent two cylinder bores and commonly used (thus, called siamese) as a portion of cylinder bore walls for defining the adjacent cylinder bores. The cylinder block outside wall 3 includes bolt bosses 6 located at the four corners of a rectangle having its center at a center of the cylinder bore. Bolt bosses located between adjacent cylinders are commonly used for the two adjacent cylinders. A bolt hole 7 is formed in each bolt boss 6. The common wall portion 5 extends in a direction perpendicular to the row of the cylinder bores. The bolt bosses 6 between adjacent cylinders and the centers of the bolt holes 7 formed in the bolt bosses 6 between adjacent cylinders are located on opposite sides of the common wall portion 5 in the direction perpendicular to the row of the cylinder bores. The bolt hole 7 includes a counter bore portion 8 (a non-threaded portion) and a threaded portion 9 located below the counter bore portion 8. In one side portion of the cylinder block outside of the bolt hole 7, a blow-by gas and oil passage 10 is formed.

The common wall portion 5 of the bore wall structure 2 and the bolt bosses 6 located on an extension of a center line of the common wall portion 5 are connected via a double bridge structure. The double bridge structure includes a lower bridge 11 located at the same level as the threaded portion 9 of the bolt hole 7 and an upper bridge 12 located above the lower bridge 11. The lower bridge 11 extends in the direction perpendicular to the row of the cylinder bores. FIG. 2 illustrates the lower bridge 11 and FIG. 4 illustrates the upper bridge 12. FIG. 3 shows the common wall portion 5 which is located between the right and left lower bridges 11 and between the right and left upper bridges 12. The common wall portion 5 is a single solid plate. Therefore, the common wall portion 5 has a large bending rigidity and can be regarded as nearly a rigid body in the direction perpendicular to the row of the cylinder bores. Since an upper portion of the common wall portion 5 contacts combustion gas and is heated, cooling water passages 13 and 14 having small diameters may be formed in the common wall portion 5 for cooling

diameter of the hole 17 should be selected so that the rigidity of the top deck is not seriously decreased. Provision of the hole 17 allows cooling water to smoothly flow in the water jacket formed in an upper portion of the cylinder block to improve cooling efficiency. In this instance, as illustrated in FIG. 9, a side surface of the lower bridge 11" may be tapered so as to change a water flow direction from a lateral direction (a horizontal direction) to an upward direction, namely, toward the cylinder head, so that the cooling efficiency of the water jacket may be further improved.

Other structures and operation of the third embodiment of the invention are the same as those of the first embodiment of the invention, and explanation on the same structures and operation will be omitted by denoting the same structural members with the same reference numerals as those of the first embodiment.

In accordance with the invention, since the bolt bosses 6 formed in the cylinder block outside wall 3 are connected to the common wall portion 5 of the siamese bore wall structure 2 by the double bridge structure including the lower bridge 11, 11', 11" and the upper bridge 12, the rigidity of the bolt bosses 6 can be increased in the direction perpendicular to the rows of the cylinder bores. As a result, when a bending moment acts on the bolt bosses 6 as a head bolt is tightened, deformation of the bolt bosses 6 is well suppressed, and deformation of the cylinder bore in the fourth mode and inclination of the top deck are also effectively suppressed. As a result, various advantages such as reduction of oil consumption, decrease in piston slap, improved head gasket durability, suppression of gas blow-by between cylinders, and decreased noise radiation from the cylinder block are obtained.

A cylinder block for an internal combustion engine includes a bolt boss (6) located between cylinders, the bolt boss (6) being connected to a common wall portion (5) of a siamese bore wall structure by a double bridge structures including a lower bridge (11, 11', 11") and an upper bridge (12) located above the lower bridge. Since a composite moment E_0 acting on the bolt boss (6) during the tightening of a head bolt is directed in a plane including the common wall portion (5), the composite moment can be born by the common portion (5) which has a very large rigidity in a direction perpendicular to the row of cylinder bores. As a result, deformation of the bolt boss (6) is suppressed, and deformation of the cylinder bore and inclination of the top deck are also effectively suppressed.

Claims

1. A cylinder block for an internal combustion engine comprising:

   a monolithic, siamese bore wall structure (2) defining a plurality of cylinder bores therein, the cylinder bores being arranged in a row and in parallel with each other, the bore wall structure (2) including a common wall portion (5) located between adjacent cylinder bores;

   a cylinder block outside wall (3) surrounding the bore wall structure (2), the cylinder block outside wall including a space for a water jacket (15) between the cylinder block outside wall (3) and the bore wall structure (2), the cylinder block outside wall (3) further including a bolt boss (6) on each side of the common wall portion (5) of the bore wall structure (2) in a direction perpendicular to the row of the cylinder bores, each bolt boss (6) including a bolt hole (7) formed therein, each bolt hole (7) having a lower threaded portion (9); and

   a double bridge structure connecting the common wall portion (5) of the bore wall structure (2) and the cylinder block outside wall (3), the double bridge structure including a lower bridge (11, 11', 11") located at substantially the same level as the threaded portions (9) of the bolt holes (7) formed in the bolt bosses (6) and an upper bridge (12) located above the lower bridge (11, 11', 11").

2. A cylinder block for an internal combustion engine according to claim 1, wherein the common wall portion (5) of the bore wall structure (2) extends in the direction perpendicular to the row of the cylinder bores so as to have a large bending rigidity in a plane perpendicular to the row of the cylinder bores.

3. A cylinder block for an internal combustion engine according to claim 1, wherein the upper bridge (12) and the lower bridge (11, 11', 11") extend in the direction perpendicular to the row of the cylinder bores.

4. A cylinder block for an internal combustion engine according to claim 1, wherein the common wall portion (5) of the bore wall structure (2) includes a cooling water passage (13, 14) formed in an upper portion of the common wall portion (5) at which the common wall portion (5) contacts combustion gas.

5. A cylinder block for an internal combustion engine according to claim 4, wherein the cooling water passage (13) includes one end open-

FIG. 1

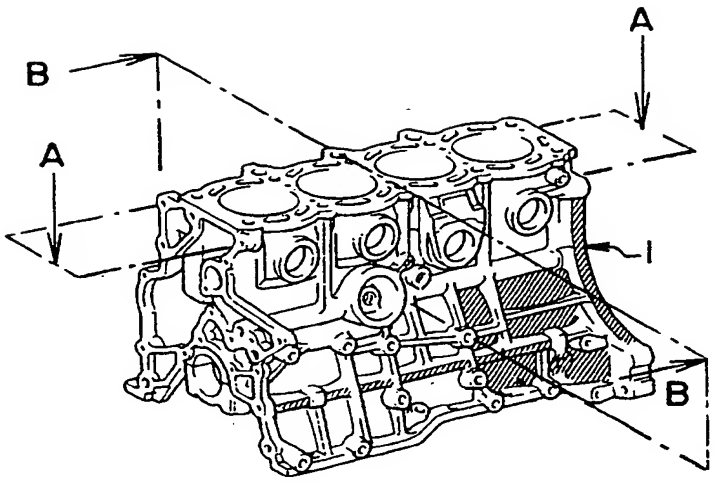

FIG. 2

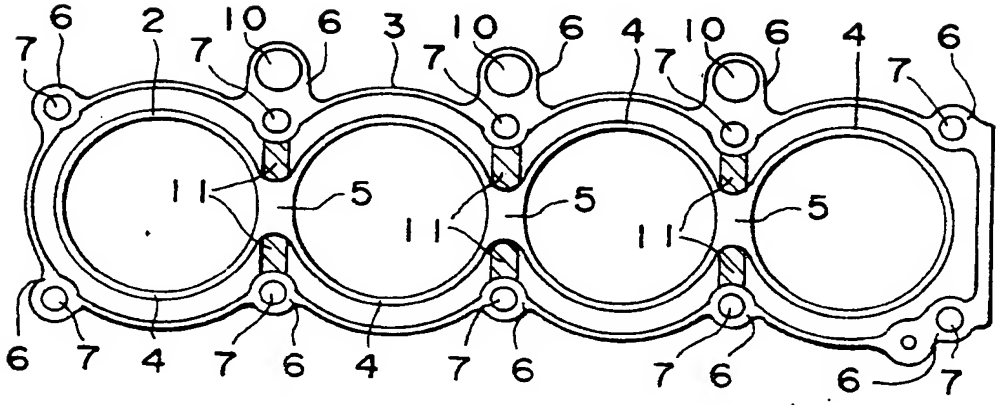

FIG. 6

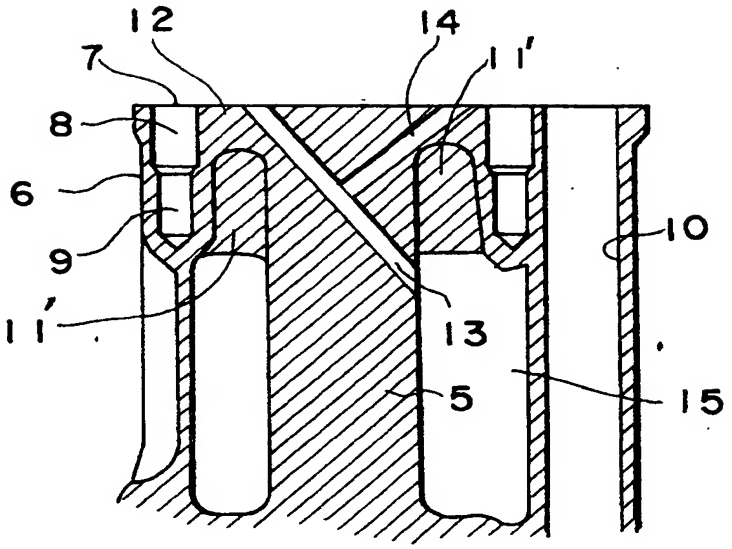

FIG. 7

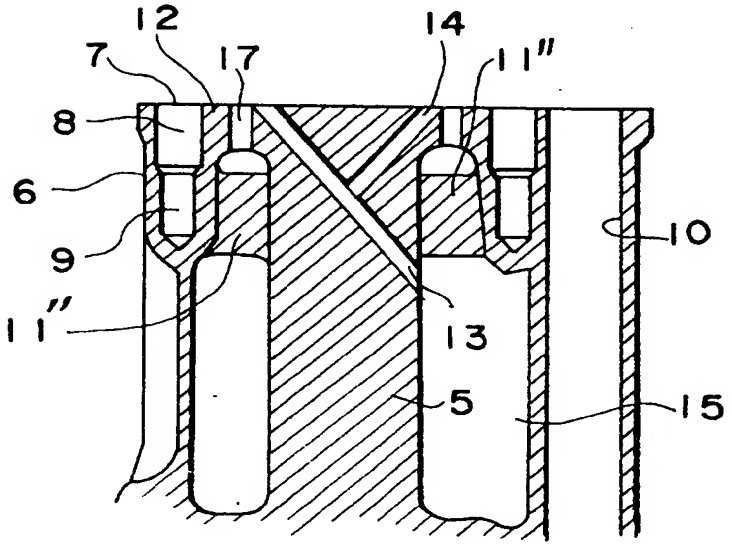

FIG. 11
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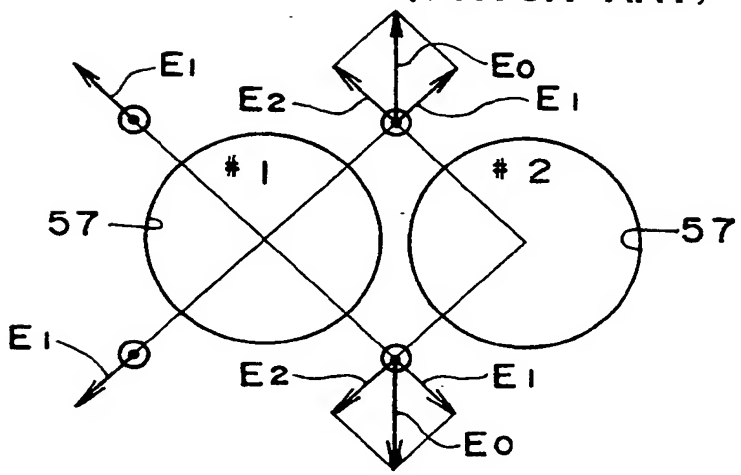

FIG. 12
(PRIOR ART)

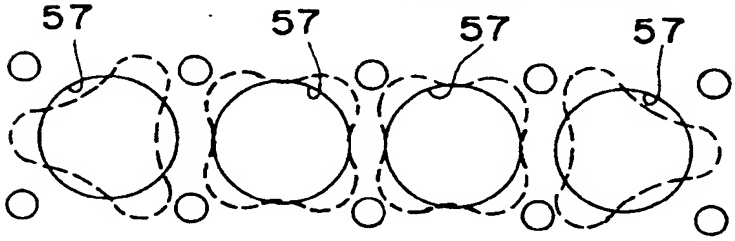

FIG. 13
(PRIOR ART)

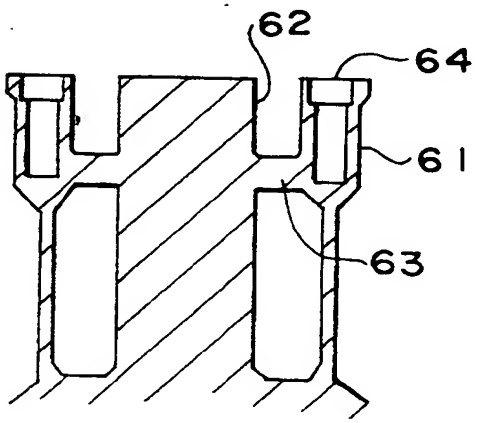

FIG. 14
(PRIOR ART)